

SUBTERRANEAN AND OTHER TERMITES

Integrated Pest Management in and around the Home

Termites comprise a large and diverse group of ecologically and economically important insects that feed on cellulose, principally in wood. Worldwide there are over 2,600 species of termites; in California there are at least 23 different species. Although many people associate termites with negative impacts, in nature they make many positive contributions to the world's ecosystems.

In California forests, woodlands, and deserts termites commonly feed on felled trees and stumps, grasses, bushes, or other pieces of dead or decaying wood. Termites can be highly beneficial as they degrade woody debris, return nutrients to the soil, and provide an energy-rich food source to a variety of predators. Their tunneling efforts help to ensure that soils are porous, contain nutrients, and are healthy enough to support plant growth. Termites rarely injure or kill trees. However, a minority of termite species can be very destructive to wood in buildings, including furniture and many other wood-based products. Each year thousands of housing units in California require treatment for the control of these insects.

SOCIAL STRUCTURE

Termites are different from most other insects in that, like ants, bees, and wasps, they are eusocial and live in colonies or societies that are highly integrated. Eusocial insects are characterized by three traits: (1) Individuals of the same species cooperatively care for immatures; (2) there is a reproductive division of labor with sterile individuals working on behalf of the reproductives; (3) there is an overlap of at least two generations in a colony so that offspring assist parents during their lifetime.

Termite colonies can vary in size from only two individuals (a mated pair or incipient colony) to hundreds of thousands or perhaps even millions of individuals. Colonies contain several forms or castes, including larvae or immatures, workers, soldiers, nymphs, and reproductives. These castes can be distinguished by physical characteristics.

Worker termites are wingless, soft-bodied, and light caramel in color (Figure 1A). They comprise the largest contingent in most colonies and are the individuals most frequently seen when infested wood is examined. Workers are reproductively undeveloped. They are responsible for the care of eggs and immatures; foraging for food; feeding and hygiene of nest mates, including the queen; and construction and maintenance of shelter tubes, galleries, and/or other colonial structures. Workers can also be involved in protection of the colony but are not as fierce as the soldiers.

Soldiers (Figure 1B) can vary greatly in morphology but, generally, have larger, amber or brownish heads and larger mandibles than workers. They guard the colony and defend it against predators.

Reproductives, or sexual adults (Figure 1C), have yellow-brown or black bodies. At maturity, they initially have two pairs of wings of equal size and are referred to as alates. After their swarming flight they shed their wings and establish new colonies. The queen is largest in physical size, attaining mass several times that of workers. Her main function is to lay eggs, sometimes thousands in a single day. A king or male reproductive is always by her side. In the more primitive termites, other



(1A) Workers



(1B) Soldiers



(1C) Reproductives (new kings and queens)

Figure 1. Various castes of dampwood, drywood, and subterranean termites. (R.L. Tabuchi, U.C. Berkeley)

individuals are capable of replacing kings or queens if they die.

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TYPES OF TERMITES

Termite pests in California include subterranean, drywood, and dampwood species. Dampwood termites derive their name from the fact that they live in moist wood, especially in stumps and fallen trees in forests. Drywood termites are common and can survive in very dry conditions, even in dead wood in deserts and do not require much moisture or contact with soil. Subterranean termites are very abundant in most parts of California, even at elevations above 8,000 feet, and live and breed in soil, sometimes many feet below the soil surface.

Dampwood Termites

Dampwood termites are common throughout the state; however, due to high moisture requirements, they are most often found in cool, humid areas along the coast. They typically infest decayed wood that remains moist either through contact with the soil or exposure to a water leak. Dampwood termites create large, open galleries within the wood where they live and feed (Figure 2, left). Their presence is significant as an indicator of a moisture problem or wood decay in wooden structures.

Drywood Termites

In California, with one exception, all species of drywood termites infest dry, sound wood—including structural lumber, dead limbs on trees, utility poles, decks, fences, lumber in storage, and furniture. From this infested wood, winged reproductives periodically swarm to infest additional nearby wood. Drywood termites are most prevalent in southern California, including the desert areas, but also occur along most coastal regions and in the Central Valley. Nests of most species remain entirely above ground and do not connect to the soil.

Similar to dampwood termites, feeding by drywood termites can cut across the grain of wood leaving a characteristic pattern of chambers and tunnels, some of which are filled with fecal pellets (Figures 2 and 3). Drywood termites often expel their fecal pellets through

surface openings and they can accumulate on horizontal surfaces below the openings (Figure 4). These fecal pellets, which are distinctive in appearance with six longitudinal flattened sides, may be the first clue to their presence. For further information on drywood termite biology and management see *Pest Note: Drywood Termites*.

Subterranean Termites

Subterranean termites are common throughout California and can be found infesting fallen trees, stumps, or other dead wood in contact with the soil in the forest, landscape, or structural lumber in our houses. The species of economic importance are within the genera *Reticulitermes*, *Heterotermes*, and *Coptotermes*. Other genera of subterranean termites found in California are mostly restricted to the desert areas in the southeastern corner of the state and are generally not important pests.

The most common subterranean termites, *Reticulitermes*, can be encountered in nearly all regions of the state, from the sand dunes of the coast to the upper elevations of the mountain ranges and even in some of the desert areas. The species of *Reticulitermes* are the most destructive termites found in California. They are small in size compared to dampwood and drywood termites, but mature colonies can contain hundreds of thousands of individuals.

Reproductive winged forms of subterranean termites are dark brown to brownish-black with brownish-gray wings. On warm, sunny days following fall or spring rains, swarms of reproductives may be seen emerging en masse from their underground nests. Soldiers are wingless with light caramel-colored bodies and long, narrow amber-colored heads with no eyes. Workers are slightly smaller than reproductives, wingless, and have a shorter head than soldiers; their color is similar to that of soldiers.

In the Sonoran Desert of southeastern California, *Heterotermes aureus* is the most destructive species of subterranean termites. This species has light-brown winged forms that fly in the early evening and are attracted to



Figure 2. Damage to wood by dampwood (left), drywood (center), and subterranean (right) termites. (R.L. Tabuchi, U.C. Berkeley)



Figure 3. Drywood termite fecal pellets are oblong with six flattened sides. The color of pellets can vary with wood species fed on. (R.L. Tabuchi, U.C. Berkeley)



Figure 4. A pile of drywood termite fecal pellets on a horizontal surface. (R.L. Tabuchi, U.C. Berkeley)

lights. Another destructive species in this group, the Formosan subterranean termite, *Coptotermes formosanus*, is native to China but now established in California, thus far restricted to a small area near San Diego. Unlike the native *Reticulitermes* but similar to *Heterotermes*, Formosan subterranean termites swarm at dusk and are attracted to lights.

LIFE CYCLE

Termite colonies are self-perpetuating. When the colony is composed of a large number of individuals, often thousands, a small percentage of individuals develop into winged reproductives (alates or swarmers) that then leave the nest, flying in swarms to mate, disperse, and establish new colonies. Most of these reproductives perish during the flight due to predation by birds, lizards, ants, or other insects. The time of day and year when flights occur varies with species and geographic location. *Reticulitermes* species swarms during the afternoon in either spring or fall on clear days after a soaking rain. *Heterotermes aureus* flies in the late afternoon or early evening in July, August, and September. *Coptotermes formosanus*, although rare in California, flies in the late evening and is attracted to lights. In buildings with heated basements, termites occasionally fly inside during winter.

New kings and queens are winged during their early adult life and generally fly less than 100 meters from their colony. Once they land on the ground they find a mate and begin the search for a nest site. A colony begins when a mated pair constructs a small underground chamber, which they enter and seal. Soon afterward mating occurs and the female begins laying eggs.

Most species of termites have microscopic one-celled organisms, called protists, within their intestines that help in converting otherwise indigestible cellulose from wood into food for the colony. Both the king and queen feed the young on predigested food, thereby transferring these intestinal protists until the new brood is able to feed themselves. Once workers are produced, the king and queen are fed by them and cease feeding on wood.

Surprisingly, termites can be long lived; queens and kings can have a life span of a decade or more, while individual workers can live for one to several years.

SIGNS OF SUBTERRANEAN TERMITE INFESTATION

Signs of a subterranean termite infestation include swarms of winged reproductives in the spring, summer, or fall, the presence of shelter tubes, and evidence of tunneling in wood. Shelter tubes (sometimes called mud tubes) are the most commonly seen evidence of a subterranean termite infestation. These earth-hardened tubes are made by workers using saliva mixed with soil and bits of wood or even drywall. There are four types of tubes:

- *working tubes* are constructed from the nest in the soil to wooden structures and they may travel up concrete or stone foundations (Figure 5A);
- *exploratory and migratory tubes* arise from the soil but do not connect to wood structures (Figure 5B);
- *drop tubes* extend from wooden structures back to the soil (Figure 5C); and
- *swarm tubes* for new and swarming reproductive kings and queens to emerge from and fly away during swarm season (Figure 5D).

If you break termite tubes open, you may see live workers and soldiers running through the tubes. The darkening or blistering of structural wood members is another possible indication of an infestation; wood in damaged areas is typically thin at the surface and easily punctured with a knife or screwdriver. Finding live termites foraging within wood is a sure sign of an active infestation.

The excavations that termites make in wood are hollow, completely enclosed, more or less longitudinal cavities. Some species deposit light-brown excrement within cavities. Feeding in wood by subterranean termites generally follows the grain of wood; these species attack the softer springwood and leave the harder, less digestible summerwood. Many times this distinctive pattern of wood damage alone can be used to positively distinguish subterranean termite activity from that of other species.



(5A) Working tubes



(5B) Exploratory and migratory tubes



(5C) Drop tubes



(5D) Swarm tubes emerging from floor crack.

Figure 5. Four types of shelter tubes.
V. R. Lewis, U.C. Berkeley (5A-C); L.L. Strand (5D)

ECOLOGICAL AND BEHAVIORAL CHARACTERISTICS OF SUBTERRANEAN TERMITES

The ecology and behavior of subterranean termites offers useful information for homeowners and the pest control industry, providing new insights into management of these potential pests.

Moisture Requirements

Subterranean termites require moist environments. To satisfy this need, they usually nest in or near the soil and maintain some connection with the soil through tunnels in wood or through shelter tubes. Furthermore, because of the moisture requirements of subterranean termites, they are often found in wood that has been slightly decayed.

Soil serves as a source of moisture that protects termites from desiccation, shields them from predators, and can be used as a building material for shelter tubes and carton nests (Formosan subterranean termites) above ground. Termites can also excavate passageways through the soil to reach additional food sources.

Reproduction and Dispersal

New subterranean termite colonies are typically started from an initial male and female pair (incipient colony). Pair formation occurs after the reproductive nuptial flight. Mated pairs usually begin laying eggs immediately. At the end of a year a colony may have grown to only 75 individuals. Very few of the reproductives that fly each year ever pair up and establish a new colony; and very few of the colonies established ever reach maturity. Colonies that survive to maturity can contain hundreds of thousands of individuals and pose a serious threat to structures.

Subterranean termite colonies may also be established by division of an existing colony. Colonies send workers to look for new food sources. If a new supply is found, then more individuals are recruited to the site. After a while, a subcolony is established with a continuous exchange of foragers between this group and the main portion of the colony. Then for any number of reasons, the subcolony may be cut off from the mother colony; and the exchange of individuals terminated. This subcolony has the capacity of producing its own reproductives and developing rapidly as an independent colony.

Foraging

Because subterranean termites usually do not build their nests in wood, they must forage for food away from the nest. In most parts of the country, foraging is essentially curtailed by winter or extremely dry periods. However, in California they can forage year-round, though the intensity of foraging varies with the season. The amount of wood consumed generally increases with increasing temperature. Foraging is minimal from November to February, moderate in spring and fall, and high,

but erratic, during the summer months. During the hot summer months of June through September, even a slight amount of rain increases the number of foragers above the soil surface and the amount of wood that a colony can consume. The optimal conditions for foraging, warm temperatures and high soil moisture, are usually present under and around buildings.

Feeding

Termites do not like all wood species, but the condition of the wood is more important in determining the probability of infestation. Decayed wood is eaten faster and preferred over sound wood. Digestion of wood, in this case, really begins before the termites take their first bite, since decay fungi in the wood break down cellulose into smaller units. Termites can digest sound wood, but decay fungi make their work much easier.

Most subterranean termite species consume wood at about the same rate, but three factors can make some species potentially more voracious and damaging than others. These factors include the environment in which they live (termites eat more wood when conditions are optimal over a longer period of time), the size of the insects (larger insects eat more wood), and the number of insects (larger colonies eat more wood).

One of the chief means of shared feeding is called trophallaxis or the mutual exchange of gut contents between colony members. Trophallaxis also permits the efficient use of nutrients, recognition of colony members, distribution of chemicals involved in caste regulation, and the transfer of cellulose-digesting protozoans. Many members of a termite colony cannot feed themselves, so they rely on other colony members to feed them. This behavior also facilitates the transfer of toxicants used in baits and other insecticides (see Management section below).

Population Biology

The nest system of subterranean termites in California consists of a network of galleries that extend into the ground

and can enlarge into more spacious chambers. The foraging territories of colonies of pest species can comprise a single foraging site or many sites around a single building, and the size of the populations utilizing these territories can range from a few tens of thousands to hundreds of thousands of individuals. A home with a footprint of 2400 square feet could have several termite colonies with hundreds of thousands of foragers seeking food and shelter (for examples of subterranean foraging territories in California see Haverty, et al. 2010 or Potter 2011 in References).

MANAGEMENT OF SUBTERRANEAN TERMITES

It is unlikely that homeowners will be able to execute subterranean termite control on their own. However, it is important for homeowners to have some familiarity with inspection procedures, reduction of conducive conditions, and treatment strategies. Successful termite management requires special skills and knowledge, including a working knowledge of building construction. An understanding of termite biology and identification can help a homeowner understand and select a suitable method of control. Of course, homeowners can replace termite damaged wood and correct conditions conducive to subterranean termite infestation on their own; however, applications of registered pesticides are highly regulated and require a licensed pest control professional to carry out the inspection and control program.

Multiple colonies of the same termite species or several different species can infest a building. A professional inspection and an integrated approach to control are required. A combination of methods, such as habitat modification, elimination of excess moisture, removal of infested wood from the structure, exclusion of termites from the building by physical and/or chemical means, and the use of chemical methods to destroy existing colonies will probably be necessary.

Inspection

An inspection by a licensed pest management professional is required before any treatments can be performed. Most homeowners will be unaware that a subterranean termite problem exists until a significant finding occurs. For instance, an infestation is discovered during an inspection in a real estate transaction, damaged wood is uncovered during a room remodel, a shelter tube appears on an interior or exterior wall, or the sudden appearance of thousands of flying insects in a bathroom or kitchen. These situations are not unusual due to the cryptic and secretive life habits of subterranean termites hidden behind walls or buried away in crawlspaces and under slab foundations.

This Pest Note and other resources found on the Internet show photos and images of termites, shelter tubes, and damage that homeowners can reference if they suspect an infestation or if they want more details about the termite inspection process before contacting a pest control professional. However, because the telltale signs of subterranean termites often occur in dark and sometime hazardous locations (attics or tight crawlspaces that have nails, dust, or standing water), it is recommended that you contact a licensed professional for inspection and subsequent treatment.

Spring time, especially a warm, sunny day following rain, is the optimal time for subterranean termite swarming behavior and, at least for brief moments during the day, a chance to see live termites and perhaps a specific location where they are emerging from in the home. Since most soil around a home has buried cellulose debris (roots, stumps, or fence posts), finding swarming termites in your yard doesn't necessarily mean your house has termites.

Homes that have had a history of subterranean termite problems can be especially vulnerable to reinfestation and should be inspected by a professional every several years. California, like most states, has nonprofit associations that provide contact information

for reputable pest control professionals in your area.

Prevention

Building design may contribute to the probability of termite invasion. Identify and correct any structural deficiencies that attract or promote subterranean termite infestations. Ideally all sub-structural wood beneath the building should be kept at least 12 inches above the soil. Consult local building codes for exact, minimum distances from wood to soil. Stucco siding that reaches the ground may promote termite infestations since termites might travel between the stucco and the foundation unseen. Keep foundation areas well ventilated and dry. Reduce chances of infestation by removing any wood in contact with the soil. Inspect porches and other structural or foundation wood for signs of termites. Look for tree stumps, stored lumber, untreated fence posts, and buried scrap wood near the structure that may contribute to a termite infestation.

Replacing Lumber in Structures

Structural lumber in buildings is usually Douglas-fir, hemlock, or spruce. Of these materials, Douglas-fir is moderately resistant to termites, whereas the other two are not. Lumber used in foundations and other wood in contact with the soil should be chemically treated or naturally resistant to termites and decay to help protect against termite damage in areas where building designs must be altered or concrete cannot be used. When using naturally resistant wood species, we recommend that you request documentation from suppliers to authenticate resistance levels stated on labeling. If susceptible wood is used above the treated wood, however, subterranean termites can build their shelter tubes over chemically treated wood and infest untreated wood above.

Use only exterior-grade, pressure-treated lumber for areas that are exposed to weather; otherwise, the chemical in the lumber may leach from the wood. All topical treatments that will be exposed to weather must also have a sealer coat to prevent leaching into the soil following rain.

Controlling Subterranean Termites

Subterranean termites in structures cannot be controlled using techniques that are appropriate for drywood termites, such as fumigation, heat treatment, freezing, and termite electrocution devices, because the reproductives and a large majority of the termites are concentrated in nests near or below ground level out of reach of these control methods. The primary methods of controlling these termites are insecticides, either applied to the soil adjacent to the structure, directly to nests via shelter tubes, or through bait stations. To facilitate control of subterranean termites, destroy their shelter tubes whenever possible to interrupt access to wooden substructures.

Insecticides. Liquid applications of pesticides are most often used for subterranean termite control and applied to the soil either in drenches or by injection. There are no reliable over-the-counter termite control products available for the public in California; all effective products are for professional use only.

Pest management professionals are provided special training because of the hazards involved in applying insecticides to the soil around and under buildings. Applications in the wrong place can cause insecticide contamination of heating ducts and/or damage to radiant heat pipes or plumbing used for water or sewage under the treated building. Soil type, weather, and application techniques influence the mobility of insecticides in the soil; soil-applied insecticides must not leach through the soil profile to contaminate groundwater or run off to contaminate surface water.

Recently, active ingredients used to control subterranean termites in soils were broadly classified as repellent or nonrepellent. Subterranean termites can detect repellent insecticides, usually pyrethroids; and they are repelled without receiving a dose that would kill them. Because of this negative reaction, termiticide products containing repellent active ingredients have been phased out.

Newly introduced chemicals are available that are less toxic to humans and other mammals than the older insecticides but remain highly toxic to insects. These insecticides, including chlorantraniliprole, fipronil, and imidacloprid are nonrepellent to termites and have been shown to be effective in killing termites at low dosage rates under California's climatic conditions. Depending on the label language, these materials are used as barriers as described above and also as local treatments, targeting nests directly via shelter tubes.

Baiting. Subterranean termite baits, which are slow-acting insecticides consumed during feeding and shared within the colony, are commercially available in California. Generally, bait is delivered within a cellulose or wood matrix infused with the active ingredient and installed underground at regular intervals around a structure. Commercial bait products are also available for above-ground use, where there is no soil for in-ground station installation. This method of controlling termites is very appealing because it doesn't require extensive site preparation, such as trenching, or extensive application of insecticides to the soil or structure, and because the most effective baits use insect growth regulators (IGRs) to suppress or destroy the entire colony. IGRs have very low toxicity to humans and their pets. The most effective bait products, however, are available for professional use only.

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Pesticides are poisonous. Always read and carefully follow all precautions and safety recommendations given on the container label. Store all chemicals in the original, labeled containers in a locked cabinet or shed, away from food or feeds, and out of the reach of children, unauthorized persons, pets, and livestock.

Pesticides applied in your home and landscape can move and contaminate creeks, rivers, and oceans. Confine chemicals to the property being treated. Avoid drift onto neighboring properties, especially gardens containing fruits or vegetables ready to be picked.

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